

1 **Supplementary information**

2 **Diversity of culturable aerobic denitrifying bacteria in the sediment, water and biofilms**
3 **in Liangshui River of Beijing, China.**

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17 **Table S1. The aerobic denitrifying bacteria in each OTU at cutoff of 0.03.**

OTUs	Strains of aerobic denitrifying bacteria
OTU 1	W6, W16, W19, W20, W22, W26, W29, W33, W35, B13, B17, B19, B20, B21, B22, B25, B26, B27, B43, B44, S18, S25, S27, S32
OTU 2	W1, W11, W12, W13, W15, W18, W21, W25, W28, W31, W32, W34, W36, W41, W42, W43, W45, B1, B11, B15, B36, B41, S1, S2
OTU 3	W7, W17, W23, W27, W37, W44, B2, B4, B10, B30, B31, B45, S10, S15, S22, S23, S28, S29, S30, S33
OTU 4	B12, S4, S5, S13, S14, S16
OTU 5	B24, B32, B33, B39
OTU 6	S7, S9, S11, S12
OTU 7	W24, W40, W46
OTU 8	W30, W38, B16
OTU 9	B14, B18, B23, B28, B29, B34, B35, B40, B42, S24, S26, S31
OTU 10	B38, S19
OTU 11	W9
OTU 12	S3
OTU 13	W4
OTU 14	S20
OTU 15	W3
OTU 16	W5
OTU 17	W2
OTU 18	S6
OTU 19	W14
OTU 20	W8
OTU 21	W10
OTU 22	B8
OTU 23	B7
OTU 24	B5

Table S2. The aerobic denitrifying bacteria in overlying water and their closest relative reference strains in NCBI database.

Strain Number	Related GenBank sequence	Closest relative (NCBI accession No.)	Identity (%)
W1	KT380544	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.79
W3	KT380545	<i>Gordonia terrae</i> strain 3612(NR037022)	99.50
W4	KT380546	<i>Stenotrophomonas acidaminiphila</i> strain AMX 19 (NR025104)	99.43
W9	KT380547	<i>Gordonia malaquae</i> strain IMMB WWCC-22 (NR115020)	98.72
W27	KT380548	<i>Pseudomonas putida</i> F1(NR074739)	99.72
W37	KT380549	<i>Pseudomonas monteili</i> (NR121767)	99.65
W43	KT380550	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.72
W2	KT380551	<i>Comamonas terrigena</i> strain NBRC 12685 (NR113597)	96.96
W5	KT380552	<i>Paracoccus versutus</i> strain NBRC 14567 (NR113662)	99.55
W6	KT380553	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.79
W7	KT380554	<i>Pseudomonas monteili</i> (NR121767)	99.93
W8	KT380555	<i>Stenotrophomonas terrae</i> strain R-32768	98.68
W10	KT380556	<i>Arthrobacter ureafaciens</i> strain NC(NR029281)	98.8
W11	KT380557	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.72
W12	KT380558	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.93
W13	KT380559	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.72
W14	KT380560	<i>Pseudochrobactrum saccharolyticum</i> strain CCUG 33852(NR042473)	99.93
W15	KT380561	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.65
W16	KT380562	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.79
W17	KT380563	<i>Pseudomonas putida</i> KT2440(NR074596)	99.65
W18	KT380564	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.79
W19	KT380565	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.72
W20	KT380566	<i>Pseudomonas mendocina</i> strain ATCC 25411 (NR114477)	98.94
W21	KT380567	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.44
W22	KT380568	<i>Pseudomonas mendocina</i> strain ATCC 25411 (NR114477)	98.74
W23	KT380569	<i>Pseudomonas monteili</i> (NR121767)	99.72
W24	KT380570	<i>Ochrobactrum rhizosphaerae</i> strain PR17 (NR042600)	99.27
W25	KT380571	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.86

W26	KT380572	<i>Pseudomonas mendocina</i> strain ATCC 25411 (NR114477)	98.67
W28	KT380573	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.51
W29	KT380574	<i>Pseudomonas mendocina</i> ymp (NR074727)	99.50
W30	KT380575	<i>Pannonibacter phragmitetus</i> strain C6-19 (NR028009)	99.35
W31	KT380576	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.79
W32	KT380577	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.86
W33	KT380578	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.65
W34	KT380579	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.72
W35	KT380580	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.72
W36	KT380581	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.72
W38	KT380582	<i>Pannonibacter phragmitetus</i> strain C6-19 (NR028009)	99.19
W40	KT380583	<i>Ochrobactrum rhizosphaerae</i> strain PR17 (NR042600)	98.75
W41	KT380584	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.79
W42	KT380585	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.65
W44	KT380586	<i>Pseudomonas putida</i> KT2440 (NR074596)	99.72
W45	KT380587	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.86
W46	KT380588	<i>Ochrobactrum rhizosphaerae</i> strain PR17 (NR042600)	99.19

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Table S3. The aerobic denitrifying bacteria in biofilm phase and their closest relative reference strains in NCBI database.

Strain Number	Related GenBank sequence	Closest relative (NCBI accession No.)	Identity (%)
B4	KT380503	<i>Pseudomonas putida</i> F1 (NR074739)	99.64
B5	KT380504	<i>Arthrobacter soli</i> strain SYB2(NR044338)	99.86
B7	KT380505	<i>Rhodococcus pyridinivorans</i> strain DSM 44555 (NR118620)	99.93
B8	KT380506	<i>Gemmobacter caeni</i> strain DCA-1(NR108321)	99.85
B16	KT380507	<i>Pannonibacter phragmitetus</i> strain C6-19 (NR028009)	99.27
B30	KT380508	<i>Pseudomonas putida</i> KT2440 (NR074596)	99.37
B36	KT380509	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.93
B38	KT380510	<i>Rhizobium pusense</i> strain NRCPB10(NR116874)	99.27
B44	KT380511	<i>Pseudomonas mendocina</i> ymp(NR074727)	98.73
B45	KT380512	<i>Pseudomonas monteilii</i> (NR121767)	99.86
B1	KT380513	<i>Pseudomonas stutzeri</i> A1501 (NR074829)	99.79
B2	KT380514	<i>Pseudomonas putida</i> KT2440(NR074596)	99.79
B10	KT380515	<i>Pseudomonas putida</i> KT2440(NR074596)	99.86
B11	KT380516	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.86
		<i>Ochrobactrum anthropi</i> strain ATCC 49188 (NR074243)	99.85
B12*	KT380517	<i>Ochrobactrum cytisi</i> strain ESC1(NR043184)	99.85
		<i>Ochrobactrum lupini</i> strain LUP21(NR042911)	99.85
		<i>Ochrobactrum tritici</i> strain SCII24(NR028902)	99.85
B13	KT380518	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.65
		<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.58
B14*	KT380519	<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.58
		<i>Pseudomonas oleovorans</i> RS1(NR115874)	99.58
B15	KT380520	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.65
B17	KT380521	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.44
B18*	KT380522	<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	98.12
		<i>Pseudomonas oleovorans</i> RS1(NR115874)	98.32
B19	KT380523	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.72
B20	KT380524	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.72

B21	KT380525	<i>Pseudomonas mendocina</i> ymp(NR074727)	98.53
B22	KT380526	<i>Pseudomonas mendocina</i> ymp(NR074727)	98.74
B23*	KT380527	<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	98.05
		<i>Pseudomonas oleovorans</i> RS1(NR115874)	98.11
B24	KT380528	<i>Rheinheimera pacifica</i> strain NBRC 103167	97.88
B25	KT380529	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.51
B26	KT380530	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.44
B27	KT380531	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.37
B28*	KT380532	<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.58
		<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.58
B29*	KT380533	<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.43
		<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.43
B31	KT380534	<i>Pseudomonas putida</i> F1(NR074739)	99.51
B32	KT380535	<i>Rheinheimera pacifica</i> strain NBRC 103167 (NR114230)	97.73
B33	KT380536	<i>Rheinheimera pacifica</i> strain NBRC 103167 (NR114230)	97.54
B34*	KT380537	<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.51
		<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.51
		<i>Pseudomonas oleovorans</i> RS1(NR115874)	99.51
B35*	KT380538	<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.65
		<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.65
		<i>Pseudomonas oleovorans</i> RS1(NR115874)	99.65
B39	KT380539	<i>Rheinheimera pacifica</i> strain NBRC 103167 (NR114230)	97.66
B40*	KT380540	<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.44
		<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.44
B41	KT380541	<i>Pseudomonas stutzeri</i> A1501(NR074829)	99.79
B42*	KT380542	<i>Pseudomonas oleovorans</i> RS1(NR115874)	98.44
		<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	98.30
B43	KT380543	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.23

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*means the isolated bacterium was unclassified at Species level based on the 16S rRNA sequence.

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Table S4. The aerobic denitrifying bacteria in sediment phase and their closest relative reference strains in NCBI database.

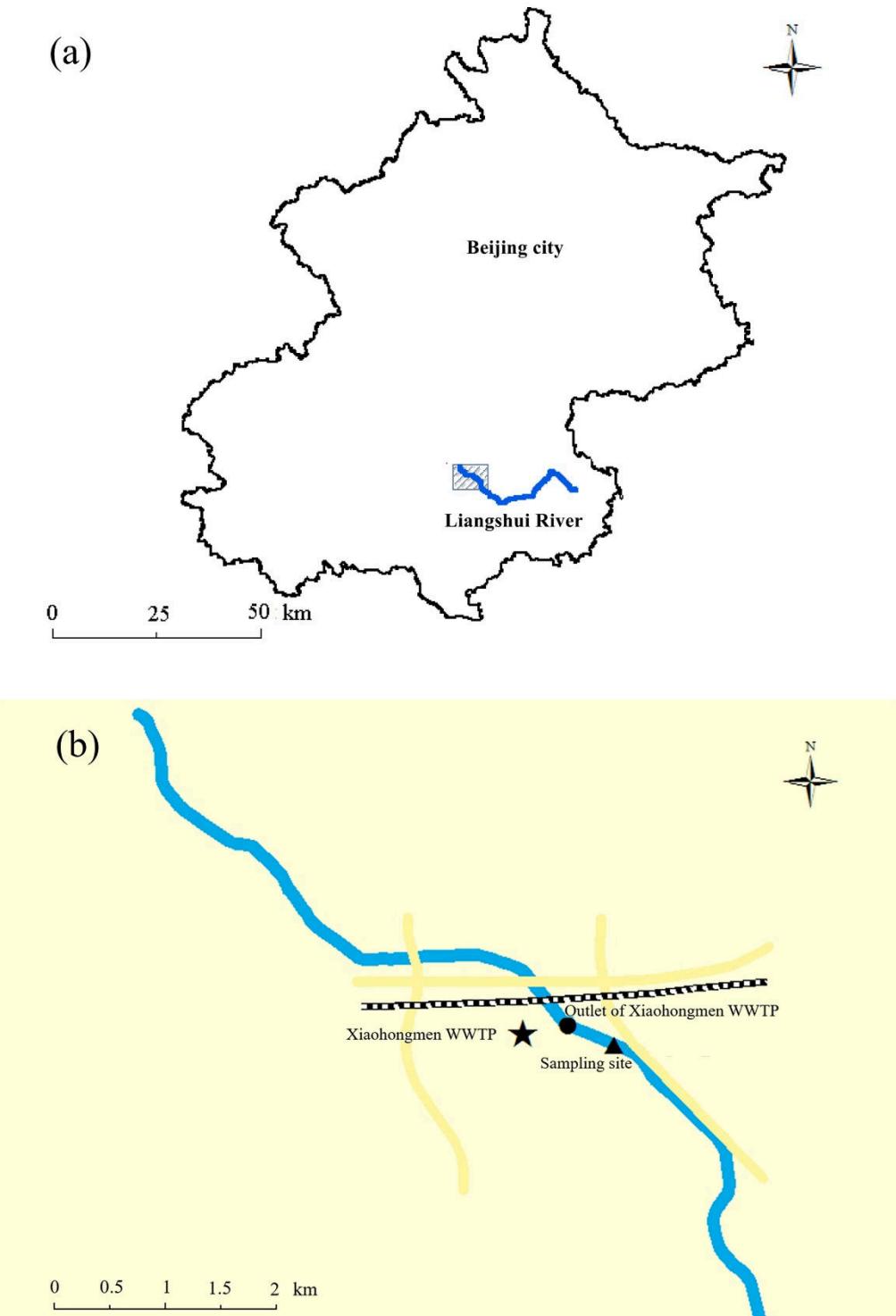
Strain Number	Related GenBank	Closest relative (NCBI accession No.)	Identity (%)
S6	KT380589	<i>Rhodococcus canchipurensis</i> strain MBRL 353 (NR109454)	99.07
S14*	KT380590	<i>Ochrobactrum tritici</i> SCII24(NR114980)	99.78
		<i>Ochrobactrum anthropi</i> strain ATCC 49188	99.49
S20	KT380591	<i>Brevundimonas diminuta</i> strain NBRC 12697 (NR113602)	99.78
S1	KT380592	<i>Pseudomonas stutzeri</i> A1501 (NR074829)	99.50
S2	KT380593	<i>Pseudomonas stutzeri</i> A1501 (NR074829)	99.30
S3	KT380594	<i>Gordonia alkanivorans</i> strain HKI 0136 (NR026488)	99.50
S4*	KT380595	<i>Ochrobactrum anthropi</i> strain ATCC 49188 (NR074243)	99.64
		<i>Ochrobactrum cytisi</i> strain ESC1 (NR043184)	99.64
S5*	KT380596	<i>Ochrobactrum tritici</i> strain NBRC 102585 (NR114148)	99.63
		<i>Ochrobactrum anthropi</i> strain ATCC 49188 (NR074243)	99.34
S7	KT380597	<i>Pseudomonas resinovorans</i> NBRC 106553 (NR103921)	98.80
S9	KT380599	<i>Pseudomonas resinovorans</i> NBRC 106553 (NR103921)	98.31
S10	KT380600	<i>Pseudomonas putida</i> KT2440 (NR074596)	99.65
S11	KT380601	<i>Pseudomonas resinovorans</i> NBRC 106553 (NR103921)	98.80
S12	KT380602	<i>Pseudomonas resinovorans</i> NBRC 106553 (NR103921)	98.93
S13*	KT380603	<i>Ochrobactrum tritici</i> SCII24(NR114980)	99.56
		<i>Ochrobactrum anthropi</i> strain ATCC 49188(NR074243)	99.27
S15	KT380604	<i>Pseudomonas putida</i> KT2440(NR074596)	99.72
S16*	KT380605	<i>Ochrobactrum tritici</i> SCII24(NR114980)	99.41
		<i>Ochrobactrum anthropi</i> strain ATCC 49188(NR074243)	99.12
S18	KT380606	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.58
S19	KT380607	<i>Rhizobium pusense</i> strain NRCPB10 (NR116874)	99.50
S22	KT380608	<i>Pseudomonas putida</i> F1(NR074739)	99.51
S23	KT380609	<i>Pseudomonas putida</i> KT2440 (NR074596)	99.65
S24*	KT380610	<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.51
		<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.51

S25	KT380611	<i>Pseudomonas mendocina</i> ymp(NR074727)	99.71
S26*	KT380612	<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.58
		<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.58
S27	KT380613	<i>Pseudomonas mendocina</i> ymp (NR074727)	99.51
S28	KT380614	<i>Pseudomonas putida</i> KT2440(NR074596)	99.37
S29	KT380615	<i>Pseudomonas monteili</i> (NR121767)	99.79
S30	KT380616	<i>Pseudomonas monteili</i> (NR121767)	99.79
S31*	KT380617	<i>Pseudomonas toyotomiensis</i> strain HT-3 (NR112808)	99.65
		<i>Pseudomonas chengduensis</i> strain MBR (NR125523)	99.65
S32	KT380618	<i>Pseudomonas mendocina</i> ymp(NR074727)	98.74
S33 *	KT380619	<i>Pseudomonas monteili</i> (NR121767)	99.37
		<i>Pseudomonas putida</i> F1(NR074739)	99.23

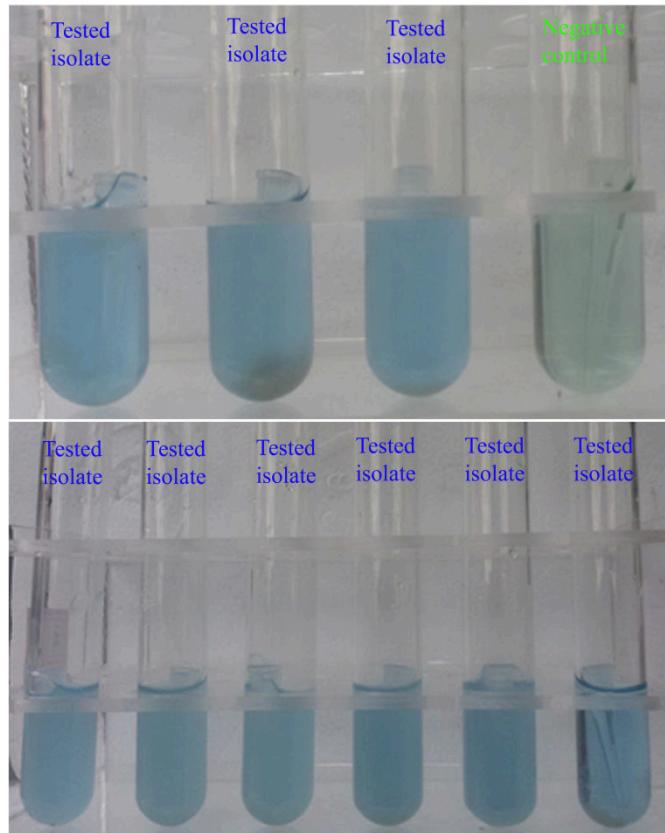
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*means the isolated bacterium was unclassified at Species level based on the 16S rRNA sequence.

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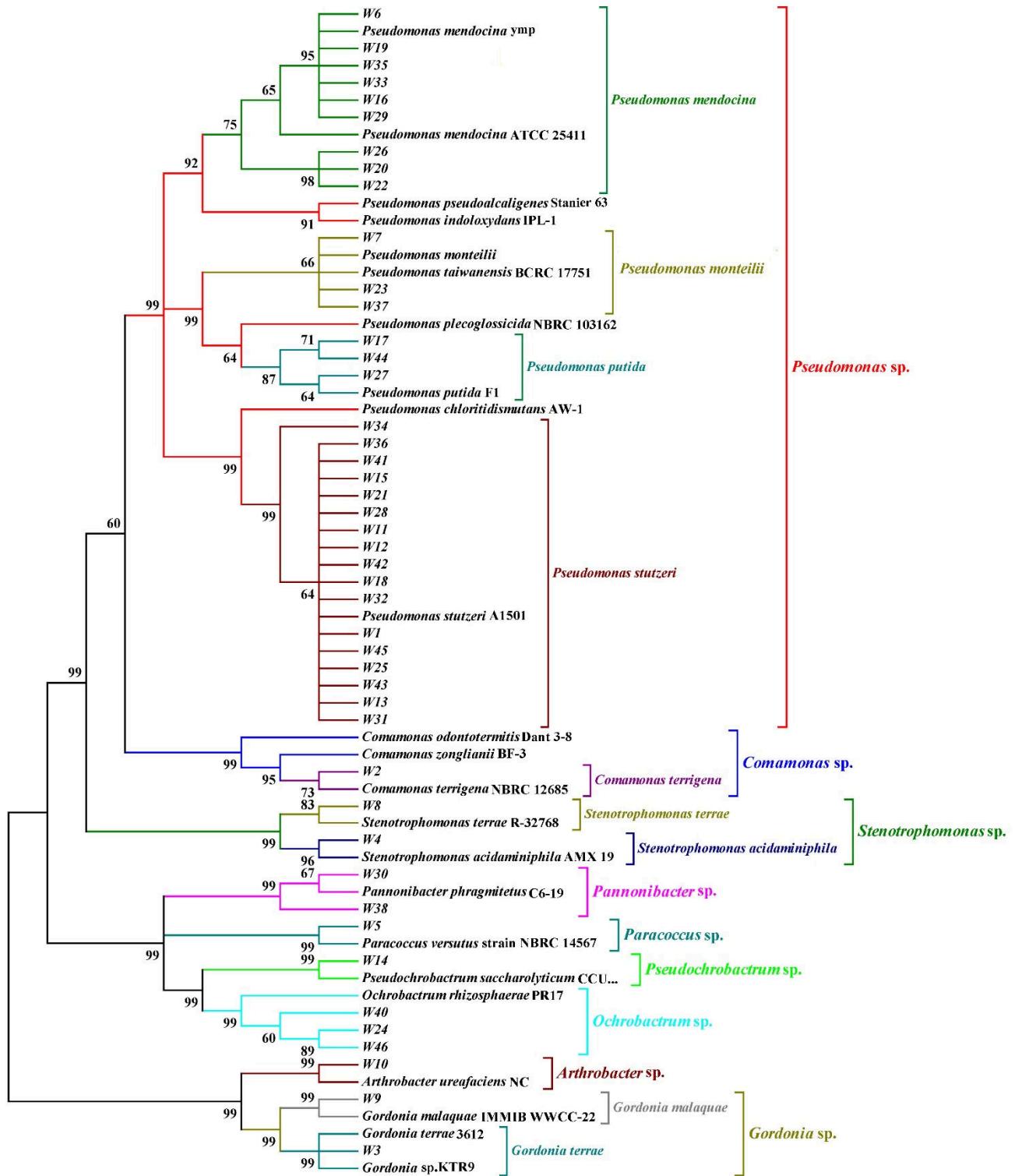
29
30 **Figure S1. (a) The location of Liangshui River in Beijing City, and (b) the location of Xiaohongmen**
31 **WWTP (★), outlet of Xiaohongmen WWTP (●) and sampling site (▲).** The pictures were created
32 by ArcMap10.3.
33



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35 **Figure S2. Screening of the aerobic denitrifying bacteria in liquid screening media.** The SM
36 containing only BTB was shown as green at pH of 7 (negative control), while the SM containing aerobic
37 denitrifiers were shown as blue (Tested isolate).

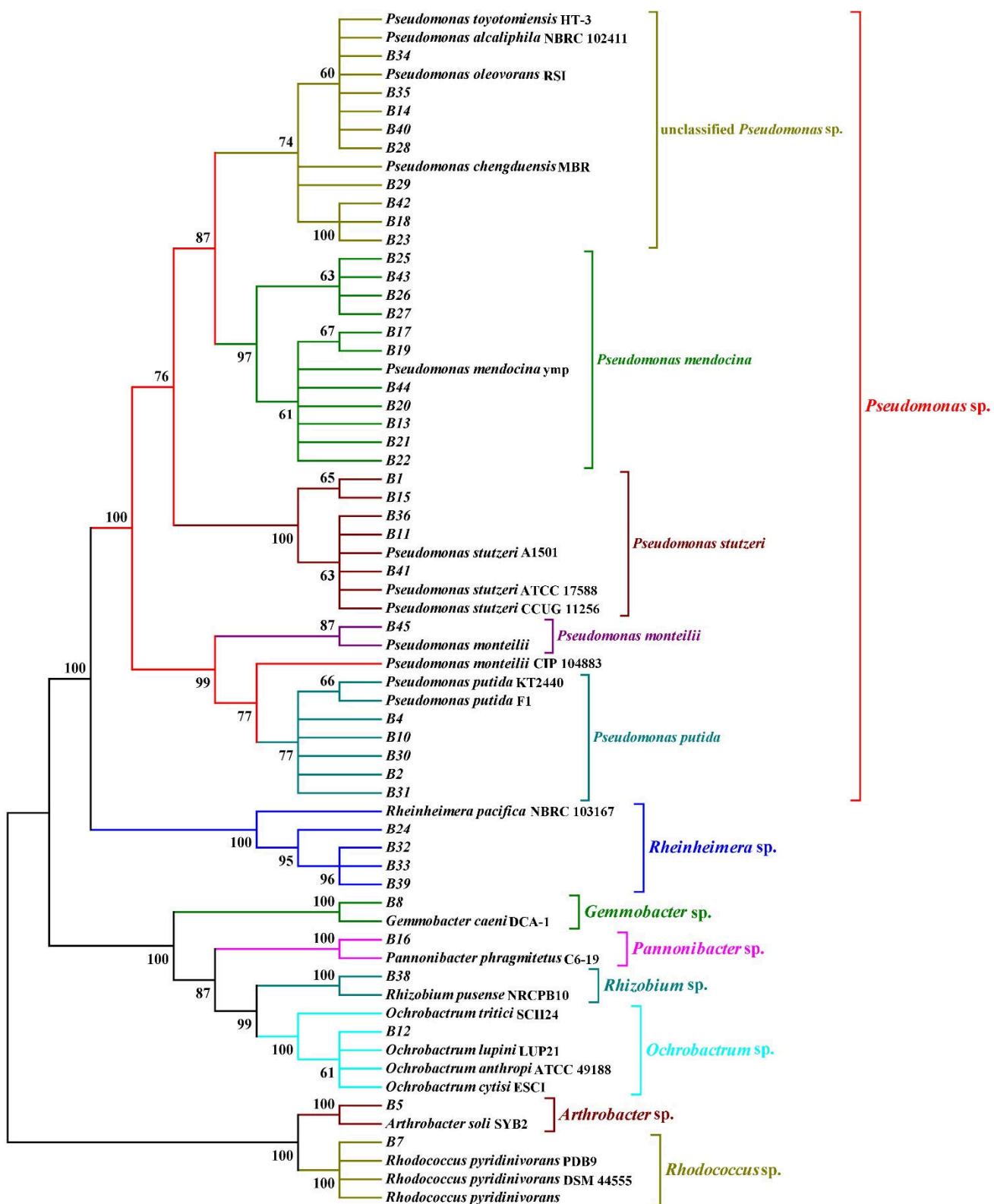
38



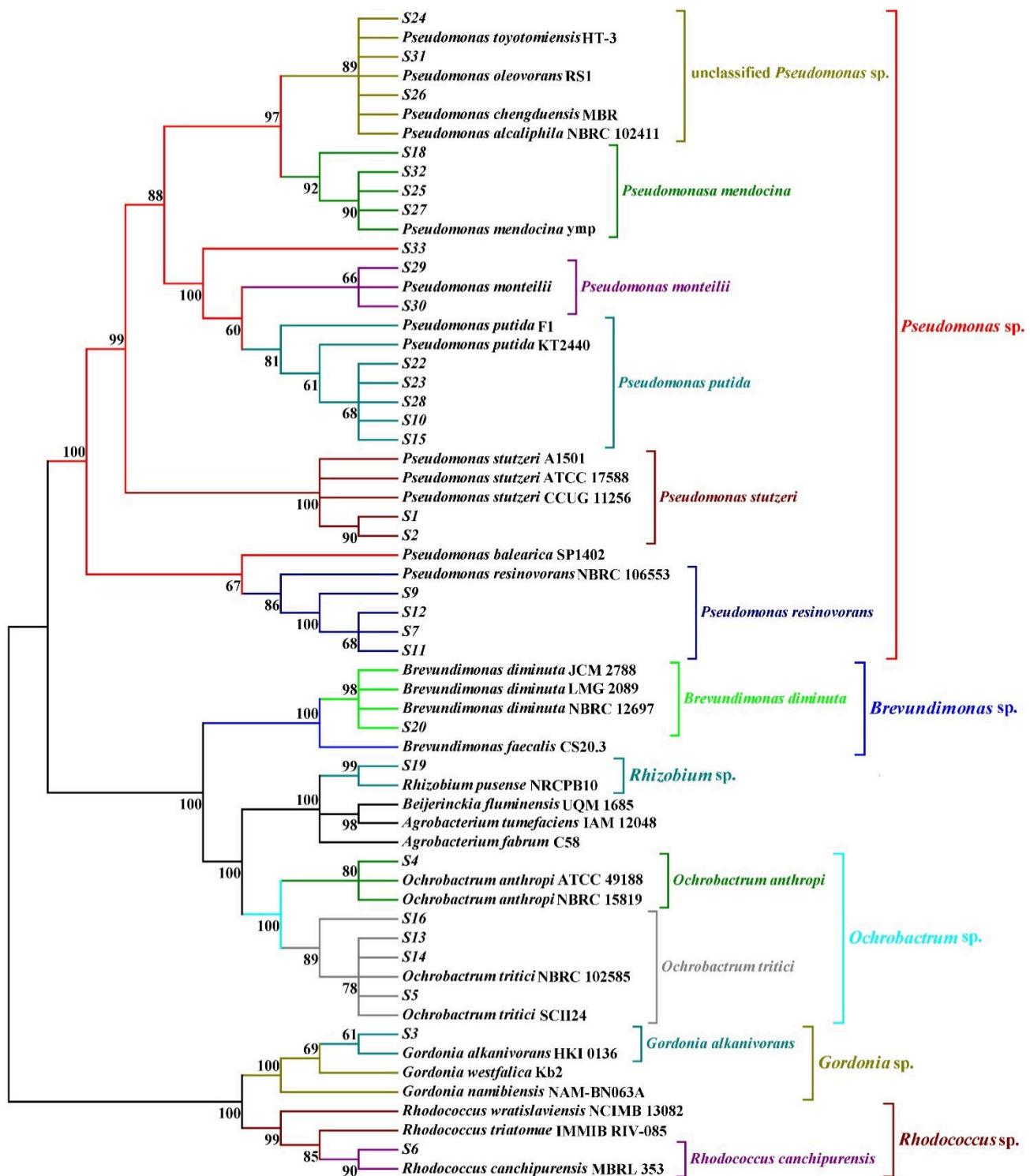
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40 **Figure S3. The phylogenetic tree (rectangular mode) for the culturable aerobic denitrifying isolates**
 41 **in the water phase of Liangshui River. The numbers next to the branches represent the bootstrap values.**

42



45 **Figure S4. The phylogenetic tree (rectangular mode) for the culturable aerobic denitrifying isolates
46 in the biofilm phase of Liangshui River. The numbers next to the branches represent the bootstrap
47 values.**



51 **Figure S5. The phylogenetic tree (rectangular mode) for the culturable aerobic denitrifying isolates**
 52 **from the sediment phase of Liangshui River.** The numbers next to the branches represent the bootstrap
 53 values.



57 **Figure S6. The supporting materials used for the biofilm growth in the Liangshui River.** The image
58 (a) shows the virginal materials while the pictures (b) and (c) represent the materials installed in the water
59 phase of the Liangshui River.